DOCUMENT RESUME

ED 388 225 IR 017 374

AUTHOR	Bourdeau, J.; And Others
TITLE	Accessing Distributed Multimedia Documents for Instructional Use.
PUB DATE	94
NOTE	7p.; In: Educational Multimedia and Hypermedia, 1994. Proceedings of ED-MEDIA 94--World Conference on Educational Multimedia and Hypermedia (Vancouver, British Columbia, Canada, June 25-30, 1994); see IR 017 359.
PUB TYPE	Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Access to Information; *Computer Networks; Database Management Systems; Distance Education; Foreign Countries; Higher Education; Integrated Learning Systems; *Multimedia Materials; *Quality Control
IDENTIFIERS	*Distributed Computing; Teleuniversity PQ; University of Montreal (Quebec)

ABSTRACT

Students, teachers, and authors need to access multimedia documents over heterogeneous networks. The efficient handling of time-dependent multimedia information such as audio and video in distributed systems requires considerable network and computing resources. The term Quality of Service (QoS) refers collectively to the specifications of these resources for a given type of service, and to the mechanisms through which these resources can be allocated. QoS is a major consideration for instructional use. A Distributed Multimedia Database (DMD) (a distributed multimedia file system augmented by some search capabilities) was developed to answer these needs. Two sites at the University of Montreal and Teleuniversity (Quebec, Canada) campuses were interconnected, each site having a number of workstations. The network configuration consists of a low-speed line between the two campuses (modems at 14.4Kbaud/sec, yielding speeds up to 32Kbits/sec), connection two LANS (local area networks) (ethernet), one on each campus. DMD is built upon two components: Apple Remote Access (ARA), and the Alias mechanism of OS 7.1. The file system is implemented on Macintoshes in HyperCard, and the user interface consists of the following: a global catalog named GC, showing the list of all files available in the DMD; file display showing retrieved files; and audio and video control panel. The DMD has been connected to an integrated learning environment, HYPERGUIDE, which provides distance education students with the structure and objectives of a course, course contents, document base, and guidance throughout the learning activities. A scenario has been designed for computer supported collaborative learning activities using the DMD. The Distributed Jigsaw scenario was implemented and tested. Accessing multimedia documents over heterogeneous networks can benefit students and authors. Facilities for QoS negotiation is critical for instructional use. (MAS)

Accessing distributed multimedia documents for instructional use

J. BOURDEAU, I. DELATEJA, G. PAQUETTE
Licef, Télé-université, P.O.Box 5250, Station C,
Montréal (Québec), H2X 3M4 Canada
Email: bourdeau@teluq.uquebec.ca

A. FRIHIDA, J. GECSEI,
Laboratoire multimedia, Université de Montréal
CP 6128 Montréal (Québec) H3C 3J7 Canada
Email: Gecsei@iro.umontreal.ca

Abstract: Students, teachers and authors need to access multimedia documents over heterogenous networks. Quality of Service (QoS) is a major consideration for instructional use. A Distributed Multimedia Database (DMD) was developed to answer these needs, allowing negotiation of QoS. The DMD has been connected to an Integrated Learning Environment, and a scenario has been designed for Computer Supported Collaborative Learning activities using DMD. The Distributed Jigsaw scenario was implemented and tested. Accessing multimedia documents over heterogenous networks can benefit students and authors. Facilities for QoS negotiation is critical for instructional use.

Students, teachers and courseware authors need to access multimedia documents that are located on different sites at a distance. How can they have access to these documents over heterogenous networks? What are the limitations and potential of different network configurations for instructional use? To answer these questions, a simple version of a distributed multimedia database (DMD) was developed providing remote access to audio, video, image and textual materials distributed over a number of sites. This DMD works over heterogeneous networks and it includes facilities for negotiating the Quality of Service. It has been tested in order to establish its praticability for instructional use. The connection with an Integrated Learning System has been done for direct access in a situation involving the creation of multimedia documents in an instructional context. A more elaborate scenario involving the use of DMD in a collaborative learning situation, called Distributed Jigsaw, has been implemented.

Needs for Instructional Use

Accessing multimedia documents distributed on different sites, among which some are at a distance, is a situation faced by students, teachers, and courseware authors. Students have as an assignment to make a search and report, or to create a multimedia document. Teachers look for material to present to their students, to prepare an assignment or an exam. Courseware authors need to screen large amounts of multimedia documents, select some of them, and edit them to produce instructional material.

Educational institutions, schools, colleges and universities, and often industries, do not have access to sophisticated infrastructures; they need technological solutions that respond to their types of activities, and that are flexible enough to take into account minimal infrastructures as well as more performing ones. The solution described below includes the design of a distributed multimedia database open to heterogenous network configurations; it states the potential and the limits for instructional use.

Database design and network configuration

Since no distributed multimedia database management system is readily available for the Apple Macintosh environment, a simple distributed multimedia database (DMD) was developed and implemented as a distributed multimedia file system augmented by some search capabilities. DMD provides for basic remote acces to multimedia files as required for instructional use, and can also be used as a testbed for experimenting with QoS problems.

Network context

High-speed communication facilities suitable for distributed multimedia applications are gradually becoming available. However, due to technical and budgetary constraints, networks currently available for experimenting are *heterogeneous*, consisting of different transmission lines and protocols. This is particularly true in situations where the network topology is fixed in advance. The direct consequence is that the quality of connection between different pairs of workstations is generally different; this in turn affects the conditions of access to remote multimedia files distributed over the workstations.

Two sites at the Université de Montréal and Téléuniversité campuses were interconnected, each site having a number of workstations. The network configuration consists of a low-speed line between the campuses (modems @14.4 Kbaud/sec, yielding speeds up to 32 Kbits/sec), connecting two LANs (ethernet), one on each campus.

Database

DMD is built upon two components: Apple Remote Access (ARA), and the Alias mechanism of OS 7.1. ARA permits access to the directories of a remote machine through a telephone line. Each workstation holds in local mass storage a number of audio and video files (in Quicktime format), as well as textual and PICT files. The purpose of DMD is to give access to all files in the system to all workstations. Ideally, access should be *transparent;* that is, when accessing a file the user should not know whether it resides in the workstation's storage or if it has to be imported from a remote site. All files in DMD are maintained in a *global directory (GD)* ; each workstation holds a copy of the GD (Fig. 1). In addition, each workstation has a *local directory* of DMD files residing in that workstation. A file which does not reside in a workstation WS is represented as an *alias* (i.e. a pointer to the original file containing its filename, volume and network adress) in WS's version of GD. A semi-automatic update procedure is used to keep the GD updated when files are added or deleted at workstations. The update takes place every time the application program is entered. For each file F, the GD entry contains the following attributes: a) name of the home workstation and the alias of the local name of F; b) title; c) type, i.e video, audio, image, or text; d) capacity and length, for audio, video, and language when applicable; e) owner; f) descriptors or keywords featuring the contents.

Quality of service

The efficient handling of time-dependent multimedia information such as audio and video in distributed systems requires considerable network and computing resources. The term Quality of Service (QoS) refers collectively to the specifications of these resources for a given type of service, and to the mechanisms through which the resources can be allocated. For example, to support video connections, throughput must be maintained continuously for acceptable video playback, and jitter (the variation of transit delay) must not exceed a certain maximum for digitized audio to be intelligible. Depending on the encoding used, audio and video data can tolerate a certain percentage of packet loss and bit errors. Some of these QoS requirements are contadictory and difficult to achieve simultaneously. For example, error control through retransmission causes additional transit delays and increased jitter. In addition to the communication of time-dependent information, control information sent between system components, such as real-time messages, is also subject to QoS constraints. In fact, QoS can be thought of as the set of *all* parameters characterizing a given distributed environment, including the range of available QoS parameters, and the facilities to negotiate them. For these reasons, QoS is becoming a central issue in distributed multimedia system design, as in the proposed Quality of Service Architecture (Campbell & al., 1993) which offers an integrated framework for QoS specification and resource control over all architectural layers of a system. QoS is also being incorporated in high-speed communication protocols such as XTP (Miloucheva & Rebensburg, 1993).

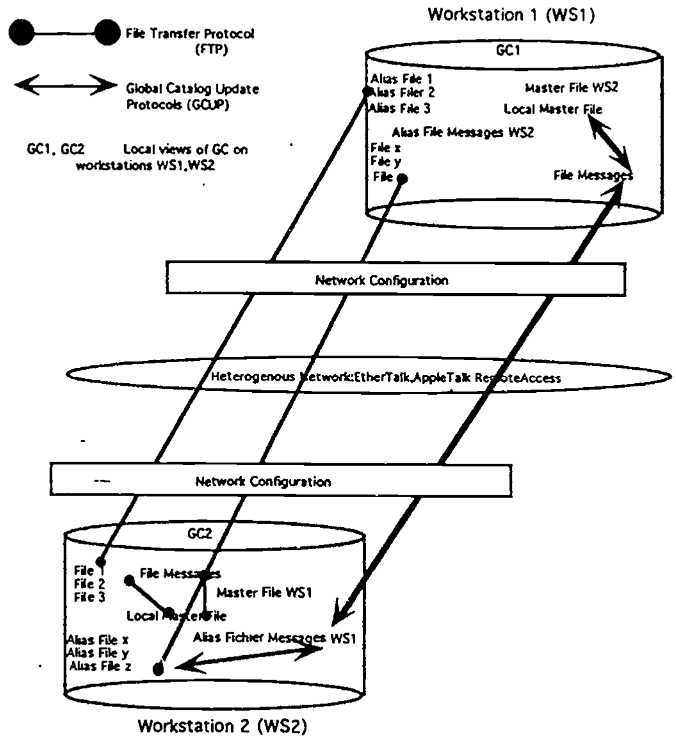

Figure 1. Structure of the Distributed Multimedia Database

A fundamental aspect of dealing with QoS is the set of interfaces through which desired levels of QoS can be requested and negotiated. They collectively allow end-to-end QoS negotiation from the user level down to the network layer. Traditionally, QoS was applied to certain features of network services, as in the transport layer, without any possible control by users. However, user control seems desirable in multimedia applications where the QoS has direct effects on the user's perception of the application, and where the system may not be able to correctly determine the user's preferences. For example, when multimedia documents are to be retrieved from remote sites, the image and video components might be displayed at high resolution, but at the price of some delay and additional cost. Alternatively, lower resolution and/or smaller displays size would be available faster and at lower cost. The DMD interface provides user control depending on the available network speed, as discussed in the next section.

DMD interface

The file system is implemented on Macintoshes in HyperCard, and the user interface consists of the following main component windows: a) a global catalog named GC, showing the list of all files available in DMD; b) attributes of the selected files; c) file display showing the retrieved file; d) audio and video control panel.

Two search modes are available, corresponding to two types of interface screen arrangements, not including another interface used for entering new files and modifying the attributes of the existing files.

The Direct search mode allows the user to make a selection from the GC. The attributes of the selected file are automatically displayed for inspection, but the file is not requested for access.

The Attribute search mode allows formulation of Boolean queries with the values of some file attributes, e.g. type, language, content descriptors. As the result of a query, a subset of the GC is generated with the files satisfying the query. A selection can then be made, as in the Direct search mode.

Accessing the selected file is done by calling the program module *network component* (NC), whose purpose is to maintain information on the underlying communication network. In the present case, it consists of a (fixed) matrix showing the available data rates between each pair of workstations in the system. In more complex situations, NC would contain additional QoS data, which might be variable in time. Conditions of accessing (e.g. waiting time) the desired file are determined through combined information from NC and GC, with three possible options:

1. The file is available locally on the user's workstation WS.
2. The file is on a workstation linked to WS through ethernet.
3. The file is on a workstation linked to WS through a 14.4 kbaud modem.

The negotiation process is the following: the user is first informed about the address of the file and the expected waiting time; she is then offered a choice as to the possible actions. In the case of video files, the choices include to view the video file directly from the source (in cases 1 and 2), to download the file to WS (cases 1, 2, 3), or to download pre-selected sections of the file, or its iconic or textual representation (case 3). Downloading entire video and audio files in Quicktime format is a very time-consuming process in case 3; that can be done off-line. This situation may rapidly change with the availability of new codecs. With more powerful equipment, real time viewing of video material through low speed telephone lines becomes possible.

Testing the system for instructional use

A series of tests has been conducted in order to establish quality of service by the DMD and its praticability for using it in learning or authoring situations. Results show that:

1) search and browsing through the DMD are effective and offer good quality,

2) importation of MM documents requires long delays that make it necessar, for users to plan either overnignt downloading (teachers or authors), or other learning activities during downloading time,

3) imported documents show a relative degradation of quality of image and sound; students and teachers may find it acceptable; courseware authors will use them for tests and need a better quality for a final production.

Connecting the DMD with an Integrated Learning System

HYPERGUIDE is an Integrated Learning System (ILS) that provides distance education students with the structure and the objectives of a course, its contents, its document base, and a guidance throughout the learning activities (Bergeron, 1993; Paquette, Bergeron & Bourdeau, 1993). HYPERGUIDE includes integrated communication facilities for students to communicate with their tutor and with other students, and to exchange files over regular phone lines. The DMD has been directly connected to the HYPERGUIDE in such a way that when the student is to make a search, the system asks her if she wants to make a search in the local base or in the distributed one. Further, selected documents from external sources such as DMD can be imported to the database. The integration of Hyperguide and DMD required the implementation of control buttons to invoke DMD, to import selected files and to return to the Hyperguide application. The Apple Events mechanism has been used in programming these functionalities. Moreover, the user interface of the DMD has been adapted to be consistent with the HYPERGUIDE interface, and a management mechanism has been developed to take in charge the documents imported from the DMD in order to integrate them into the resident document base.

Using the DMD in a distance course

HYPERGUIDE is the ILS used in a course entitled "Introduction to Training" at Télé-université. In this course, students are given a classification task where they have to make a search in a document base and compose a structured multimedia document based on the results of their search. These materials (files) include written descriptions, diagrams, spoken explanations, video clips showing particular work situations, etc. Only a small number of files are appropriate in a given situation, and the student's competence is judged from her ability to select the appropriate files. This activity, in order to be meaningful, requires a large file system with a variety of available and reusable materials coming from various sources. Hence the need for the distributed file system described above. In the present form of the course, video documents are analog, and distributed to students through the Télé-université TV channel as well as on videocassettes. For the purpose of this project, the video documents relevant to the classification task have been digitized and made available to the DMD as Quicktime movies.

The classification task is done by students who work at a distance as a team; they access the DMD, import MM documents, exchange files over a telephone network, compose their own MM document, and finally send it to their tutor. A scenario for this teamwork has been elaborated based on the Jigsaw model [Slavin, 1986], in which subtasks of a problem are first assigned to teams of students; when the subtasks are mastered, the teams redistribute so that every new team contains an "expert" for each subtask. Every new team must then find a solution to the posed problem, and finally the solutions are compared and discussed among the teams. This method, proved to be efficient in the teaching of various subjects, was transferred to a Computer Supported Collaborative Learning (CSCL) situation. The resulting scenario, called *Distributed Jigsaw* (DJ), is designed to support distant cooperative learning; it is rich in opportunities for cooperation and reciprocical teaching, with the following six events (Fig. 2):

1. Problem definition and identification of subtasks, normally part of the course instructions.
2. Forming distributed teams and assigning subtasks to the team members by teleconferencing
3. Individual study within teams. Each member becomes an "expert" on a subtask by searching for materials and composing a multimedia document.
4. Teleconference of the "experts" by subtask; here the students compare and elaborate their results together with the members of other teams working on the same subject, leading to modifications in their documents.
5. Return to the original teams; members present their knowledge and documents to the team.
6. Synthesis of results within each team, composition of the solution, i.e. a complex document.

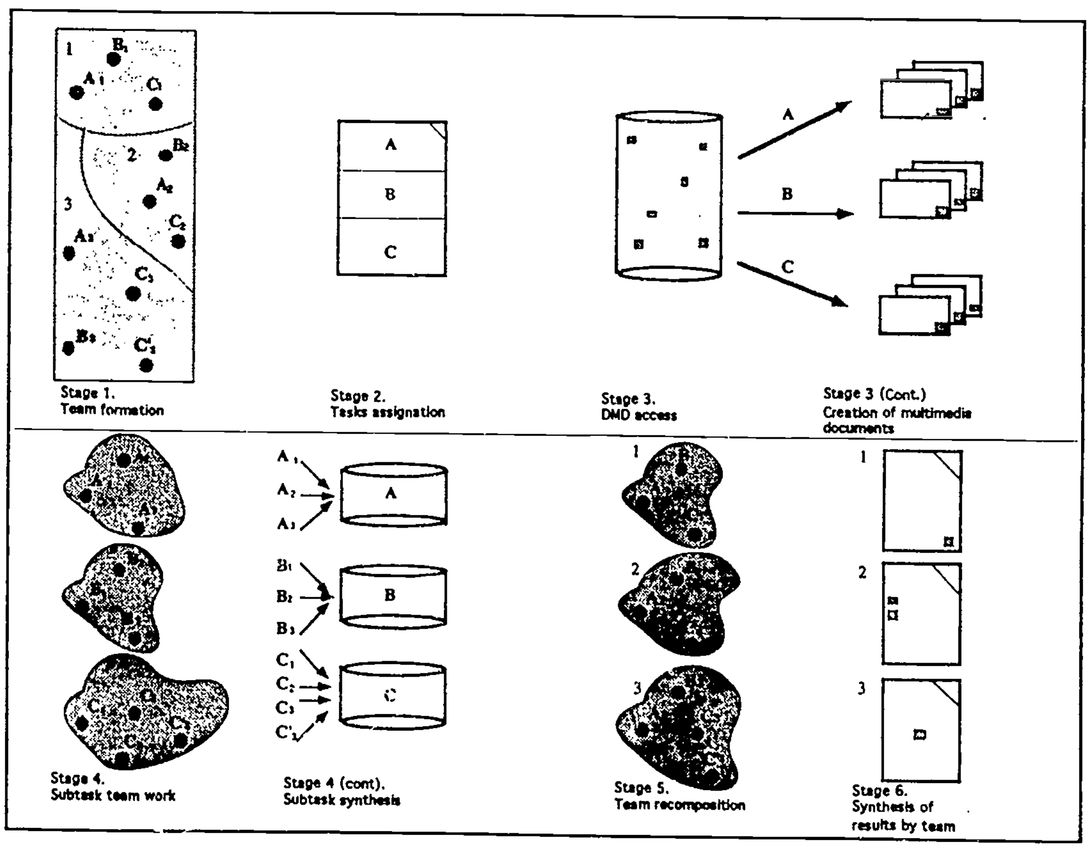

Figure 2. The Distributed Jigsaw scenario

Conclusions and future work

This first experience shows that the availability of high-speed transmission facilities, enabling real-time access to multimedia files, is not essential. The adverse effect of offline access to such files through slow lines can be minimized through proper work organization (e.g. overnight downloading) and through proper use of resources (e.g. freeing the computer during the waiting time). Students, teachers and courseware authors can benefit from accessing MM documents using a low-speed communication infrastructure. The opportunity given to users for negotiating QoS is essential.

A second phase of this project aims at testing the system and experimenting the scenario on a high-speed broadband type of link high speed link between two distant sites, the cities of Montréal and Québec (300 km). The DMD will be implemented under a Windows environment for this purpose. The design of CSCL activities and of the software to support them will be studied in the light of Salomon's reflections (Salomon, 1992).

References

Bergeron, G. (1993). *Hyperguide*, Proceedings of ED-MEDIA'93, Orlando, Florida (poster).

Campbell, A., Coulson G., Garcia, F., Hutchison, D., Leopold, H. (1993). *Integrated Quality of service for Multimedia Communications*, IEEE Infocom'93, San Francisco, March 1993.

Miloucheva, I., and Rebensburg, K. (1992). *XTP service classes and routing strategy for an integated service broadband environment*, Proc. IWACA, Munchen, 1992.

Paquette G., Bergeron G. & Bourdeau J. (1993).*The Virtual Classroom revisited*, Proceedings of Teleteaching'93, August 23-26, Trondheim, Norway.

Slavin, R. (1986). *Student team learning* . National Education Association, Washington, DC.

Salomon, G. (1992). What does the design of effective CSCL require and how do we study its effects? in *SIGCUE Outlook, Special Issue on Computer-Supported Collaborative Learning*, ACM Press, Spring 1992.

Acknowlegdments

We are indebted to Clement Gagnon for technical support, to Stephane Liegeois for connecting DMD and HYPERGUIDE and for digitizing the video documents, and to the Centre de recherche informatique de Montreal for financial support.